

AMENDMENT

To: Examiner of the Patent Office

1. Indication of the International Application

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4. Item to be Amended: Description and Claims

5. Subject Matter of Amendment

- (1) The words "a discharge hole through which the working fluid is discharged from the working chamber into a discharge space, and flow-in timing control means which controls the flow of the working fluid into the suction hole, in which the expander expands the working fluid, wherein the expander which expands the working fluid further comprises pressure ratio control means which varies a ratio between pressure when expansion stroke of the working chamber is started and pressure when the expansion stroke is completed" which appears on page 8, lines 7 to 12 of the specification should be amended as "and a discharge hole through which the working fluid is

discharged from the working chamber into a discharge space, wherein the discharge hole is provided with a differential pressure regulating valve which is operated by a difference between pressure in said working chamber and pressure in the discharge space".

- (2) The words "Especially, the excessive expansion loss can be prevented from being generated with an extremely simple structure that the differential pressure regulating valve is only added to the discharge hole of an expander." should be added after the words "the expander can be prevented." which appears on page 8, line 17 of the specification.
- (3) The words which appears on page 8, line 19 to page 9, line 1 of the specification should be deleted.
- (4) The words "fourth" which appears on page 9, line 2 of the specification should be amended as "second".
- (5) The words "third" which appears on page 9, line 3 of the specification should be amended as "first".
- (6) The words "fifth" which appears on page 9, line 12 of the specification should be amended as "third".
- (7) The words "fourth" which appears on page 9, line 13 of the specification should be amended as "second".
- (8) The words "sixth" which appears on page 9, line 19 of the specification should be amended as "fourth".
- (9) The words "fourth" which appears on page 9, line 20 of the specification should be amended as "second".
- (10) The words which appears on page 9, line 25 to page 10 line 28 of the specification should be deleted.
- (11) The words "an eleventh" which appears on page 10, line 29 of the specification should be amended as "a fifth".
- (12) The words "tenth" which appears on page 10, line 30 of the specification should be amended as "fourth".
- (13) The words "twelfth" which appears on page 11, line 5 of the specification should be amended as "sixth".
- (14) The words "any one of the first to eleventh aspects"

- which appears on page 11, line 6 of the specification should be amended as "the fifth aspect".
- (15) The words "thirteenth" which appears on page 11, line 15 of the specification should be amended as "seventh".
 - (16) The words "twelfth" which appears on page 11, line 16 of the specification should be amended as "sixth".
 - (17) The words "a discharge hole through which the working fluid is discharged from said working chamber into a discharge space, and flow-in timing control means which controls the flow of the working fluid into said suction hole, in which the expander expands the working fluid, wherein the expander which expands the working fluid further comprises pressure ratio control means which varies a ratio between pressure when expansion stroke of the working chamber is started and pressure when the expansion stroke is completed" which appears in claim 1 should be amended as "and a discharge hole through which the working fluid is discharged from said working chamber into a discharge space, wherein said discharge hole is provided with a differential pressure regulating valve which is operated by a difference between pressure in said working chamber and pressure in said discharge space".
 - (18) The words "claim 3" which appears in claim 4 should be amended "claim 1".
 - (19) The words "claim 4" which appears in claim 5 should be amended "claim 2".
 - (20) The words "claim 4" which appears in claim 6 should be amended "claim 2".
 - (21) The words "claims 1 to 10" which appears in claim 11 should be amended "claims 1 to 4".
 - (22) The words "any one of claims 1 to 11" which appears in claim 12 should be amended "claim 5".
 - (23) The words "claim 12" which appears in claim 13 should

be amended "claim 6".

(24) Claims 2, 3, 7-10 should be cancelled.

6. List of Attached Documents

(1) Replacement sheet of pages 8 to 11 of the
specification

(2) Replacement sheet of pages 34 and 35 of claims

for partitioning a space formed by the cylinder, the roller and the closing member into a plurality of working chambers, a suction hole through which working fluid flows into the working chamber, and a discharge hole through which the working fluid is discharged from the working chamber into a discharge space, wherein the discharge hole is provided with a differential pressure regulating valve which is operated by a difference between pressure in the working chamber and pressure in said discharge space.

With this aspect, even if the pressure in the discharge space is varied, the pressure in the working chamber and the pressure in the discharge space when the expansion stroke is completed can match with each other, and excessive expansion loss of the expander can be prevented. Especially, the excessive expansion loss can be prevented from being generated with an extremely simple structure that the differential pressure regulating valve is only added to the discharge hole of an expander. Thus, an efficient expander can be provided.

According to a second aspect of the invention, in the expander of the first aspect, the differential pressure regulating valve is closed when the pressure in the working chamber is lower than the pressure in the discharge space.

With this aspect, when the excessive expansion is generated in the expansion stroke, if the differential pressure regulating valve is closed to tightly close the working chamber, the working fluid in the working chamber is repressed, the excessive expansion loss can be prevented from being generated.

According to a third aspect of the invention, in the expander of the second aspect, the differential pressure regulating valve is a reed valve.

With this aspect, the differential pressure regulating valve is closed when the excessive expansion is generated. It is possible to constitute the differential pressure regulating valve extremely easily.

According to a fourth aspect of the invention, in the expander of the second aspect, the differential pressure regulating valve has a circular conical valve portion.

With this aspect, since the wasted volume caused by the discharge hole becomes small, deterioration in efficiency can be prevented.

According to a fifth aspect of the invention, in the expander of any one of the first to fourth aspects, fluid which expands from liquid phase or supercritical phase to gas-liquid two-phase is used as the working fluid.

When fluid expands from liquid phase or supercritical phase to gas-liquid two-phase, a specific volume of the working fluid is largely varied depending upon a ratio of gas and liquid and excessive expansion or incomplete expansion is prone to

be generated. According to this aspect, even when the excessive expansion or incomplete expansion is prone to be generated, it is possible to suppress the excessive expansion loss, and the efficiency of the expander can be enhanced.

According to a sixth aspect of the invention, in the expander of the fifth aspect, the expander is utilized in a heat pump cycle which uses carbon dioxide as the working fluid.

The carbon dioxide is environmentally friendly but a difference between high pressure and low pressure of the heat pump cycle is great, and even when the pressure ratio is slightly varied, a large excessive expansion loss is generated. With this aspect, the efficiency of a high pressure using the carbon dioxide can be enhanced.

According to a seventh aspect of the invention, in the expander of the sixth aspect, a shaft of the expander is directly connected to a shaft of a compressor used in the heat pump cycle.

With this aspect, excessive expansion when the expander is started can be prevented, no torque variation is generated. Therefore, the compressor of the heat pump cycle can efficiently and smoothly be started.

Brief Description of the Drawings

Fig. 1 is a vertical sectional view of an expander of a first embodiment of the present invention;

Fig. 2 is a transverse sectional view of the expander of the first embodiment of the invention;

Fig. 3 is a PV diagram of a working chamber of the expander of the first embodiment of the invention;

Fig. 4 is a transverse sectional view of an expander of a second embodiment of the invention;

Fig. 5 is a vertical sectional view of the expander of the second embodiment of the invention;

Fig. 6 is a vertical sectional view of an expander of a third embodiment of the invention;

CLAIMS

1. (amended) An expander comprising a cylinder, a shaft having an eccentric portion, a roller which is fitted to said eccentric portion and which eccentrically rotates inside said cylinder, a closing member for closing both end surfaces of said cylinder, a vane for partitioning a space formed by said cylinder, said roller and said closing member into a plurality of working chambers, a suction hole through which working fluid flows into said working chamber, and a discharge hole through which the working fluid is discharged from said working chamber into a discharge space, wherein said discharge hole is provided with a differential pressure regulating valve which is operated by a difference between pressure in said working chamber and pressure in said discharge space.

2. (amended) The expander according to claim 1, wherein said differential pressure regulating valve is closed when the pressure in said working chamber is lower than the pressure in said discharge space.

3. (amended) The expander according to claim 2, wherein said differential pressure regulating valve is a reed valve.

4. (amended) The expander according to claim 2, wherein said differential pressure regulating valve has a circular conical valve portion.

5. (amended) The expander according to any one of claims 1 to 4, wherein fluid which expands from liquid phase or supercritical phase to gas-liquid two-phase is used as the working fluid.

6. (amended) The expander according to claim 5, wherein the expander is utilized in a heat pump cycle which uses carbon dioxide as the working fluid.

7. (amended) The expander according to claim 6, wherein a shaft of said expander is directly connected to a shaft of a compressor